

## EFFECTS ON POSTURAL CONSTRAINTS ON OVERARM THROWING

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This study explored the effects of postural constraints on overarm throwing. 10 participants were required to perform an overarm throwing movement by 3 tasks which under postural constraints. Tasks were including trunk-fixed, sitting, and standing. 10 pieces of 3D motion capture system were used to record the maximum velocity of body segments as data and one-way repeated measures ANOVA ( $\alpha=.05$ ) with HSD post-hoc tests was conducted to analysis the data. Therefore, the results indicated that the performance of overarm throwing by 3 tasks were different significantly, which proved the kinetic chain formed by links connected in series gave body segments more velocities. Moreover, it meat trunk and lower limbs played the roles to transport velocity as performing overarm throwing.

**KEY WORDS:** kinetic chain, velocity, transport.

**INTRODUCTION:** Velocity is one of the key factors to determine sports game winning and it could be corroborated through a 100-meter dash in track and field competitions or as baseball pitcher throwing fastballs. Besides, accuracy is another common factor which could be observed during basketball shooting. What affect velocity could be athletics' muscular strength, endurance, and instantaneous power and physical strength as well as their coordination, agility and skills to different sports. Nevertheless, coordination was investigated in this study. Kreighbaum and Barthels (1996) characterized forward accelerating movement which performing by body segments in proximal-to-distal sequencing as throw-like movement. As body segments involved in a series of linked movements, that is kinetic chain. Many researchers conducted movement analysis to investigate the 6 phase of throwing movement and found out that it was associated with kinetic chain in series (Dillman, Fleisig, & Andrews, 1993; Sachlikidis & Salter, 2007). It also pointed out that in a throwing movement proceeding, not only upper and lower limbs but also trunk, which connected with, interact (Chu, Fleisig, Simpson, & Andrews, 2009). Therefore, this study adopted 3 tasks which under postural constraint: trunk-fixed, sitting (with legs lift up 90°), and standing (with one stride away) to observe the effects of trunk and limbs on overarm throwing movement.

**METHODS:** The participants were 10 sport-majored male students whose right hand was dominated and their physical were reported non-injured before. Participants were required to perform an overarm throwing movement by 3 tasks: sitting (Fig. 1 left), trunk-fixed (Fig. 1 middle), and standing (Fig. 1 right). During throwing, participants' left hand (non-dominated) was fixed on waist then throw ball to the target 10 m away as hard as they could. 10 pieces of 3D motion capture system (Vicon, MX-F40) were used to record the kinematic pattern of ball, finger, hand, forearm, upper arm and trunk as data. One-way repeated measures ANOVA ( $\alpha=.05$ ) with HSD post-hoc tests was conducted to analysis the data.



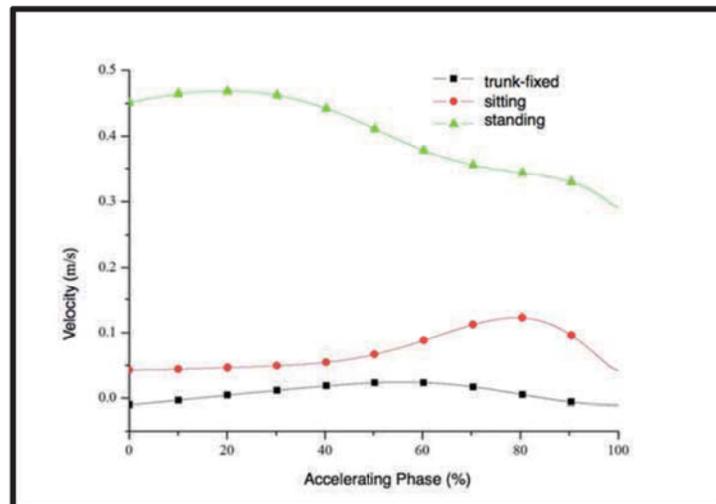
Figure 1: Tasks including sitting (left), trunk-fixed (middle), and standing (right).

**RESULTS AND DISCUSSION:** Under 3 tasks constraints, the maximum velocities of each body segments were presented in table 1. The result of trunk ( $F(2, 18) = 46.98, p < .01, \eta^2 = .83, \text{power} = 1.00$ ), upper arm ( $F(1.24, 11.17) = 174.49, p < .01, \eta^2 = .95, \text{power} = 1.00$ ), forearm ( $F(2, 18) = 113.31, p < .01, \eta^2 = .92, \text{power} = 1.00$ ), hand ( $F(2, 18) = 63.25, p < .01, \eta^2 = .87, \text{power} = 1.00$ ), finger ( $F(2, 18) = 51.63, p < .01, \eta^2 = .85, \text{power} = 1.00$ ), ball ( $F(2, 18) = 19.07, p < .01, \eta^2 = .67, \text{power} = 1.00$ ), it revealed that the maximum velocity of standing was greater than trunk-fixed and sitting.

**Table 1**  
**Maximum Velocities (m/s)**

N=10 Parameter	trunk-fixed		sitting		standing	
	M	SD	M	SD	M	SD
trunk	0.01	0.07	0.12	0.14	0.51	0.11
upper arm	0.97	0.25	2.34	0.38	3.60	0.53
forearm	2.83	0.56	4.38	0.65	6.16	0.85
hand	5.88	0.81	7.60	0.91	9.20	1.18
finger	6.65	0.78	8.25	0.93	9.80	1.20
ball	11.79	1.75	14.38	2.39	15.20	2.92

In Figure 2, the curve line represented the velocity of trunk during accelerating phase. It showed that the velocity of trunk in trunk-fixed overarm throwing toward 0. About sitting, although participants' lower limbs were under constraint, they had to use their trunk to move forward for increasing velocity to throw the ball. In task of standing, participants' trunks were moved forward to increase velocity continuously then as the ball was released the velocity was declined. This was kinetic chain yield out a condition of brake, which encored the point of view to Kreighbaum and Barthels (1996) as displacement of body segments in series.



**Figure 2: Velocity of trunk during accelerating phase before ball released.**

Figure 3, 4 and 5 were the velocity of upper arm, forearm, hand during accelerating phase before ball released. It showed that in task of standing, the lower limbs interacted with trunk, the velocity was the greatest. Then, sitting, which used trunk to make movement, came after. The task of trunk-fixed which used upper limbs to throw ball only had the smallest velocity. From above, it pointed out that the less constraints the better movement.

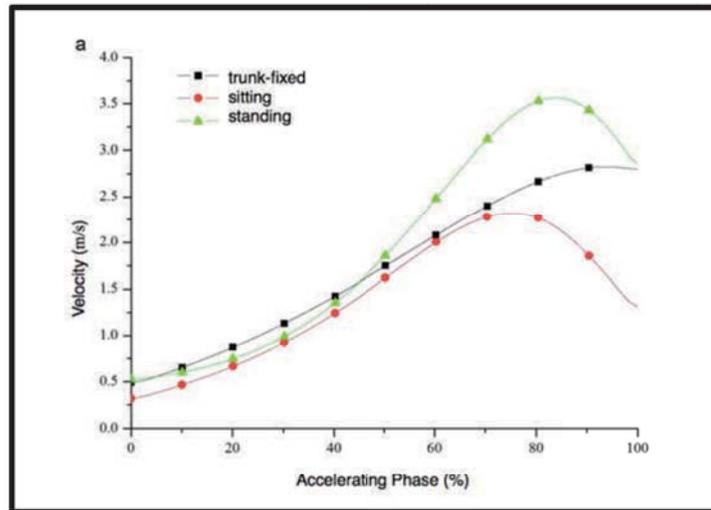


Figure 3: Velocity of upper arm during accelerating phase before ball released.

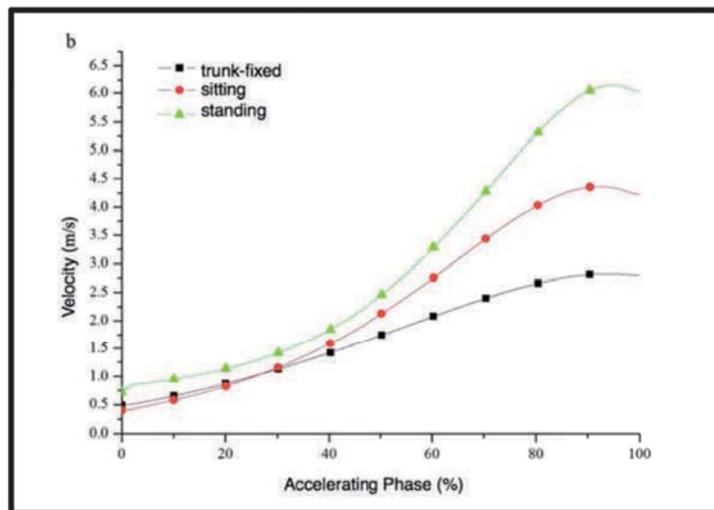


Figure 4: Velocity of forearm during accelerating phase before ball released.

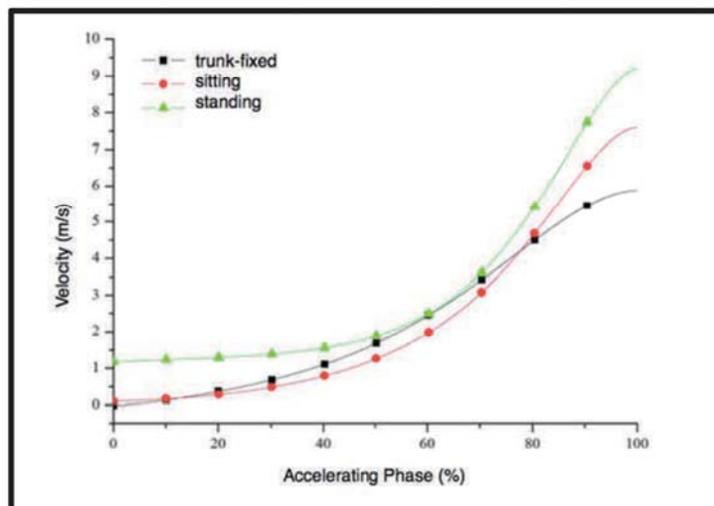


Figure 5: Velocity of hand during accelerating phase before ball released.

**CONCLUSION:** This study explored that the upper and lower limbs affected the desired qualities of movement and the trunk which connected limbs affected it as well. Therefore, as athletics training, they should not only focus on the movement of upper and lower limbs but also to strengthen the movement of trunk to avoid their limbs overloading.

**REFERENCES:**

- Chu, Y., Fleisig, G. S., Simpson, K. J., & Andrews, J. R. (2009). Biomechanical comparison between elite female and male baseball pitchers. *Journal of Applied Biomechanics*, 25, 22-31.
- Dillman, C. J., Fleisig, G. S., & Andrews, J. R. (1993). Biomechanics of pitching with emphasis upon shoulder kinematics. *Journal of Orthopaedic and Sports Physical Therapy*, 18(2), 402-408.
- Kreighbaum, E., & Barthels, K. M. (1996). *Biomechanics: A Qualitative Approach for Studying Human Movement* (4th ed.). New York: Allyn and Bacon.
- Sachlikidis, A., & Salter, C. (2007). A biomechanical comparison of dominant and non-dominant arm throws for speed and accuracy. *Sports Biomechanics*, 6(3), 334-344.